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FREQUENCY AND INTENSITY OF FREEZING RAIN/DRIZZLE IN OHIO

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Eastern Region
Garden City, NY

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UNITED STATES DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE EASTERN REGION
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NOAA TECHNICAL MEMORANDUM NWS ER-51

FREQUENCY AND INTENSITY OF FREEZING RAIN/DRIZZLE IN OHIO

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FREQUENCY AND INTENSITY OF FREEZING RAIN/DRIZZLE IN OHIO

I. *BACKGROUND*

During the winter seasons of 1970 and 1971, the author received several requests from cable television companies and from insurance companies regarding the frequency and intensity of ice storms in Ohio. A search of available literature failed to uncover pertinent information on this subject. It was because of the interest and total lack of information on ice storms in Ohio that this study was undertaken.

II. *DISCUSSION*

Detailed data related to the occurrences of freezing precipitation are available only from daily observational forms prepared at first-order National Weather Service offices. The original observational forms are collected by the National Climatic Center, but carbon copies of the forms are usually retained by each first-order office. For this study, National Weather Service offices in Ohio were asked to provide the following for each period of freezing rain and/or drizzle* (hereafter referred to as rain/drizzle) during the years 1951 through 1970: the date, time freezing rain/drizzle began and ended, wind direction and speed, type of freezing precipitation, and the amount (melted) of freezing rain/drizzle which fell during each period in question. With the exception of Mansfield, all data summarized in this study are for the period 1951-1970. (The Mansfield information was derived from 1961-1970 data.)

From data provided by the eight first-order stations in Ohio, monthly and seasonal tabulations were prepared on the frequency of days with freezing rain/drizzle. Arithmetic averages were calculated for each monthly and seasonal tabulation. Table 1 gives, for eight Ohio locations, the average number of days with freezing rain/drizzle for each month October through April and the winter season. For the entire winter season, the average number of days with freezing rain/drizzle ranged from 9-days at Cincinnati and Columbus to 15 days at Youngstown. In an "average" Ohio winter, Youngstown is the first and last Weather Service Office to record freezing rain/drizzle.

While information contained in *TABLE 1* is of value, probability information on the occurrences of freezing rain/drizzle would be

* *For this study sleet is treated as freezing rain/drizzle.*

more useful. Thom (1966) has suggested the Poisson probability distribution applies for rare events such as annual tropical cyclones, tornadoes, hail, and excessive precipitation frequencies. Since the occurrence of freezing rain/drizzle is a rare event, the author tested the adequacy of the Poisson distribution to fit such a frequency. A subsequent chi-square test showed the fit of the Poisson distribution to the freezing rain/drizzle data to be good. It is acknowledged, however, that the chi-square test is of questionable validity at the extremes of a Poisson distribution. The 20-year period of data available also makes questionable the values obtained at the longer return periods (i.e. $\geq$50 years). A programmable calculator was used to calculate the Poisson probability

$$P = \sum_{x=0}^{c} e^{-m}m^{x}/x! \quad \text{for } x \leq c$$

where m = the mean value
c = value of the integer

Sufficient integer values were used with monthly and annual averages for each location to determine probabilities to the .99 level. Output from the Poisson probability routine was used to construct information contained in *TABLE 2*. This table, showing calculated recurrence intervals, hereafter called return periods, gives the annual number of days with freezing rain/drizzle for return periods of 2, 5, 10, 25, 50, and 100 years. While similar information was obtained for each month (October through April), samples of these data are not included in this study. At the 2-year return level the number of days with freezing rain/drizzle ranged from 8 days at Cincinnati and Columbus to 14 days at Youngstown. For the 100-year return period, the values ranged from 16 days at Cincinnati and Columbus to 23 days at Youngstown.

Some idea regarding the intensity of a particular ice storm may be obtained from the hourly observations of equivalent melted precipitation which fell during the period in which freezing rain/drizzle was observed. A major problem with such storms is that freezing rain/drizzle collects on all sides of precipitation gages and will not be properly accounted for on recording gages. At synoptic observation times, the sides of the gages are scraped to account for the melted equivalent of precipitation which fell during the preceding 6-hour period. If the sides of the gage are not scraped clean, the melted equivalent of freezing rain/drizzle either will not be accounted for at all or will be accounted for in some future observational period. In spite of the inherent difficulties associated with obtaining the equivalent melted precipitation amounts of freezing rain/drizzle, all first-order stations in Ohio, except Cincinnati, provided such information for each period of freezing rain/drizzle covered by this study.

For the study years, more than one period of freezing rain/drizzle was observed on many days (e.g., Dayton reported 420 periods of freezing rain/drizzle during 1951-1970, Toledo 392, and Cleveland 340). Therefore, it was necessary to combine the equivalent melted precipitation amounts for all periods of freezing rain/drizzle which occurred during a single day before statistics from ice storms could be summarized. Once this was done, the precipitation (melted) amounts were tallied under one of the following categories: trace, .01-.05, .06-.10, .11-.20, .21-.30, and greater than .30 inch. *TABLE 3* gives a summary of the 1951-1970 percentage frequencies associated with the above specified ranges of precipitation (melted). Data in this table show the daily freezing rain/drizzle precipitation amounts associated with Ohio ice storms were less than .06 inch on 72.6 to 89.6% of the days with freezing rain/drizzle in Ohio. Less than 4% of all ice storm days produced freezing rain/drizzle (melted) amounts exceeding .30 inch (i.e., except for Toledo where the percentage was 4.6).

In addition to frequency and intensity of freezing rain/drizzle, there may also be some interest in wind directions and speeds associated with ice storms. These statistics would allow a potential user of such information to estimate the additional stress which wind might add to utility lines, buildings, trees, etc. *TABLE 4* gives the percentage frequencies associated with selected ranges of wind speeds (knots) observed during periods of freezing rain/drizzle. Most ice storms occur with wind speeds in the 6 to 14 knot range. Wind speeds in excess of 23 knots rarely accompany freezing rain/drizzle. The percentage frequencies associated with observed wind directions during periods of freezing rain/drizzle are summarized in *TABLE 5*; the two highest frequencies are underlined for each location. High frequencies are noticeably absent for winds blowing from the south-southeast through west-southwest directions. In Ohio, wind directions of north through southeast are most commonly associated with freezing rain/drizzle.

III. SUMMARY

A mean recurrence table of annual number of days with freezing rain/drizzle for return periods of 2, 5, 10, 25, 50, and 100 years was devised for eight Ohio locations from output generated from a Poisson probability routine. For a return period of 2 years, the number of days with freezing rain/drizzle ranged from 8 days at Cincinnati and Columbus to 14 days at Youngstown. Relative frequencies associated with six ranges of precipitation amounts (melted) collected during days with freezing rain/drizzle showed the equivalent daily precipitation amounts associated with Ohio ice storms were less than .06 inch on 72.6 to 89.6% of the days with freezing rain/drizzle. Wind direction and speeds associated with periods of freezing rain/drizzle were also summarized. Wind speeds of 6 to 14 knots were most common during periods of freezing rain/drizzle. The information presented in this study could be used to determine the probable stress which buildings, utility lines or other objects would have to withstand from ice storms in Ohio.

REFERENCE

Thom, H. C. S., "Some Methods of Climatological Analysis", *World Meteorological Organization Technical Note No. 81*, 1966, pp. 30-31.

TABLE 1. Average number of days with freezing rain/drizzle at eight Ohio locations.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	YEAR
Akron	0	1	4	4	3	2	*	14
Cincinnati	0	1	3	2	2	1	*	9
Cleveland	0	1	3	4	2	1	*	11
Columbus	0	1	2	3	2	1	*	9
Dayton	0	1	2	4	2	1	*	10
Mansfield	0	1	4	2	2	2	*	11
Toledo	0	1	3	4	3	2	*	13
Youngstown	*	1	4	4	3	2	1	15

* *Less than one half.*

TABLE 2. Recurrence table of annual number of days with freezing rain/drizzle for indicated return periods.

	Return Period (Years)					
	2	5	10	25	50	100
Akron	13	16	18	20	21	22
Cincinnati	8	11	12	14	15	16
Cleveland	10	13	15	17	18	19
Columbus	8	11	12	14	15	16
Dayton	9	12	14	15	16	17
Mansfield	10	13	15	16	17	18
Toledo	13	16	18	20	21	22
Youngstown	14	17	19	21	22	23

TABLE 3. Percentage frequencies associated with selected ranges of precipitation amounts (melted) collected during days with freezing rain/drizzle.

	Trace	.01-.05	.06-.10	.11-.20	.21-.30	>.30 inches
Akron	51.4	28.8	08.9	04.6	02.7	03.6
Cleveland	67.1	22.5	03.3	04.2	01.0	01.9
Columbus	50.0	31.3	06.1	07.1	02.0	01.5
Dayton	59.0	26.7	05.6	06.0	00.8	01.9
Mansfield	44.2	28.4	11.8	09.8	02.9	02.9
Toledo	42.1	35.9	08.5	05.8	03.1	04.6
Youngstown	50.0	37.0	05.7	04.0	02.8	00.5

TABLE 4. Percentage frequencies associated with selected ranges of wind speeds observed during periods of freezing rain/drizzle.

	<6	6-14	15-23	>23 KNOTS
Akron	3.1	54.6	40.2	2.1
Cleveland	4.0	59.7	33.4	2.9
Columbus	11.7	71.8	16.4	0.1
Dayton	3.4	71.0	25.1	0.5
Mansfield	9.7	68.3	22.0	0.0
Toledo	6.8	61.7	30.4	1.1
Youngstown	7.0	67.8	23.6	1.6

TABLE 5. Percentage frequencies associated with observed wind directions during periods of freezing rain/drizzle.

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Akron	4.7	2.6	8.3	3.9	3.5	5.2	7.8	3.9	6.6	3.9	6.6	4.3	8.7	8.3	10.5	10.9
Cleveland	10.9	10.3	7.2	4.6	4.3	7.7	7.7	6.6	5.4	2.8	2.8	5.5	6.3	5.7	5.8	5.2
Columbus	11.7	2.7	8.6	5.0	7.4	3.1	11.3	1.5	8.9	4.3	5.8	2.7	5.0	2.7	9.7	9.3
Dayton	8.8	11.4	4.7	6.5	10.4	5.7	9.1	4.9	6.5	3.9	3.1	4.1	4.4	3.9	3.9	8.3
Mansfield	6.1	8.5	6.1	2.4	6.1	7.3	15.8	2.4	6.1	0.0	8.5	4.8	11.0	6.1	4.8	3.6
Toledo	6.9	5.8	10.1	14.5	12.7	8.3	4.7	4.4	2.9	2.3	4.2	6.8	1.5	4.4	6.8	5.2
Youngstown	4.3	4.6	3.4	3.9	4.3	10.4	14.1	6.7	6.1	2.7	6.7	6.7	8.0	5.5	5.8	6.7

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NWS ER 40 Use of Detailed Radar Intensity Data in Mesoscale Surface Analysis. Robert E. Hamilton. March 1971 (COM-71-00573)

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NWS ER 42 A Case Study of Radar Determined Rainfall as Compared to Rain Gage Measurements. Martin Ross. July 1971 (COM-71-00897)

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